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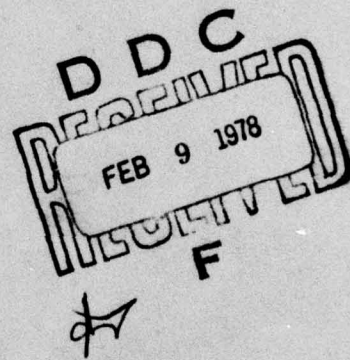
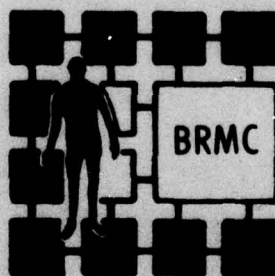
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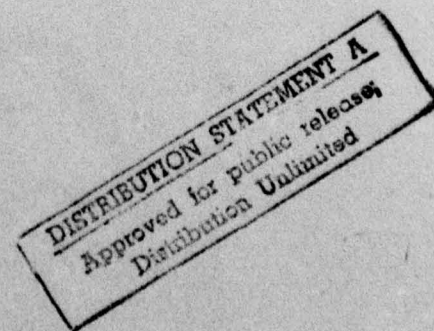
SEMIANNUAL BUSINESS RESEARCH REPORT

A Compendium Prepared by:

Air Force Business Research Management Center



30 September 1977



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report is a compendium of acquisition-related research being performed in the USAF. It is designed to give the reader a quick overview of the research efforts and provides a quick overview of the research efforts and provides sufficient information to follow-up on projects of interest. 409.450 Jmc		

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Reliability Management
Life cycle Cost

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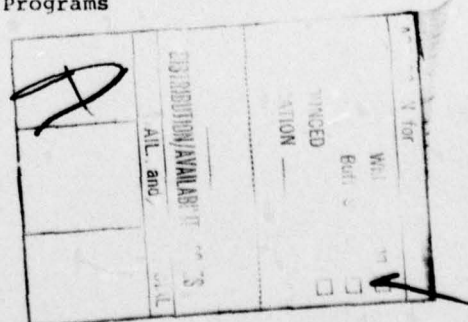
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*One-half of the research program is reported each issue. Therefore, for an annual report, both issues should be reviewed. The preceding report, dated 31 March 1977, had the following content:	
Requirements Generation	Support Acquisition
Business Strategy	Contractor Motivation Procurement Productivity
Program Management	Production Management Management Information System Design-to-Cost
Logistics	Industrial Base Quality Assurance
Business Environment	Inflation Impact of Socio-Economic Programs



FOREWORD

This report is part of a continuing effort to provide current, accurate, and complete information on the latest research concerning problem areas of general concern to the procurement and acquisition community. It is not, therefore, directed toward providing "answers" to immediate problems. Rather, it is intended to provide information on how problems of a fundamental and deep-seated nature are being conceptualized and analyzed. For keeping abreast of the new information being developed in the procurement and acquisition communities, however, this report should be high on every reader's list.

This report is designed to be read quickly; therefore, it contains summary level information. For more detailed discussion, we provide executive summaries, one-to-three page narratives of the most promising research. We also have final reports available for readers who wish to study the research in detail. The BRMC research manager will be pleased to provide any further information you may desire.

For prospective researchers, the report provides brief descriptions of research needs which have come to our attention. In our experience it is virtually impossible to communicate in writing in sufficient detail to permit researchers to initiate study on the basis of the initial written description. Our intention, therefore, is to spur interest and thought. Researchers whose areas of interest are not mentioned, or those who have a product which they would like to bring to our attention, are urged to call the BRMC research manager. We are always glad to learn of promising opportunities and products.

Similarly, members of the procurement and acquisition community are invited to provide potential research subjects and to bring to our attention any promising study results which we may not have come across. In doing so, you will greatly assist us in creating one of the primary values of this report: a continuing dialog regarding the problems and issues which concern the procurement and acquisition communities today, and a glimpse of those which should concern them tomorrow.

DANIEL E. STRAYER, Lt Col, USAF
Executive Director
Air Force Business Research Mgmt Center

ORGANIZATION OF THE REPORT

The Air Force Business Research Management Center (BRMC) is a focal point, under AFR 20-5, for procurement/acquisition-related research studies. Operating under the functional guidance of HQ USAF/LGP, the BRMC matches acquisition problems with existing research capabilities, manages and monitors selected research efforts, tests research results, and when warranted assists in implementing resulting recommendations for improvement. The BRMC also consults with management to help it use procurement and acquisition research results. To provide a framework for conceptualizing the procurement/acquisition process, the BRMC has defined the following "acquisition practices:"

Requirements Generation - Processes of establishing needs to be satisfied by acquisition from the private sector of our economy.

Business Strategy - All processes involving the establishment of business management plans, contractual relationships, and the alignment of specific Air Force functions involved in establishing a business relationship with the private sector.

Program Management - The processes of planning, organizing, and controlling internal Air Force activities to insure that contracted program needs are satisfied.

Logistics - All processes related to the provision of life cycle systems support.

Business Environment - Those aspects of our procurement/acquisition process which are designed to permit us to accommodate conditions which arise externally and over which we have no direct control.

These acquisition practices are divided into research areas and further subdivided into individual research projects. A BRMC research area manager is responsible for relating the ongoing research effort in each area to other research efforts in that area, as well as to other research areas in the total procurement/acquisition process. The research manager is thus in a unique position to assist operating managers and potential researchers to assure that their knowledge base is both current and complete.

PART I - RESEARCH PROGRAM STATUS

REQUIREMENTS GENERATION: Processes of establishing needs to be satisfied by acquisition from the private sector of our economy.

SUPPORT REQUIREMENTS

Area Manager: Captain Paul W. Gross, Jr.

Objective: To improve the wholesale/retail level support decision processes that allocate resources to Air Force operating and support functions. The primary areas of concern are requirements generation and inventory management and control. Requirements generation includes, but is not limited to, provisioning, spares computation, depot maintenance repair computation, and equipment requirements determination. Inventory management and control deal with depot/base interface and stock control and distribution policies.

Background: The USAF logistics support system involves the USAF, the Air Force Reserve, Air National Guard, other U.S. Government agencies, and air forces of nations receiving U.S. security assistance. As of 1975, the Air Force Logistics Command (AFLC) managed a \$13.8 billion inventory with over 800,000 line items. The diversity of applications, operational concepts for deployments, and the number of items involved greatly complicates the managerial task. Resource allocation decisions in the total logistics spectrum (e.g., plans and programs, requirements, distribution maintenance, and redistribution and marketing) impact the acquisition process. Before procurement action begins, basic questions of need, quantity, lead time, and cost must be considered. In our complex environment, the various questions are usually expressed in terms of models, many of which are automated. The automated models depend upon various types of computational techniques to reach approximately optimal decisions within specific constraints.

Significance: Present Air Force automated computational techniques, system software, and Air Force policy can be improved by research. Means must be found to analyze the effects of constraints (e.g., fund limitations) on decisions. Studies should be directed toward refining support concepts, techniques, and procedures.

Projects Completed(*)/In Progress:

*1. Project Number C-2-13-76. "An Examination of the USAF Policies for Managing Depot-Base Inventories," Dr. L. Schwarz, University of Rochester. Research Director: Captain Paul W. Gross, Jr.

a. Summary: Based upon the results of a previous research study, the objective of this study was to compare current Air Force depot/base inventory policy on economic order quantity (EOQ) items with various alternative inventory policies in order to determine if current policy can be improved. The policies were evaluated using 50 F-4 aircraft EOQ items by computer simulation. The two alternative inventory policies which were evaluated with current policy are: allocation policy and system myopic variant to current USAF policy. To understand these several alternatives, consider a system consisting of several bases and a depot supplying them. In all three policies each base independently determines the reorder point (or level) at which more material is ordered; similarly, the depot independently defines the reorder level at which it restocks its inventory.

In the current USAF EOQ inventory policy each base independently determines the order quantity EOQ that minimizes cost for that base considered alone; similarly, the depot independently determines its order quantity. The depot ships materiel on any order until it runs out of stock.

In the allocation policy base and depot EOQs are determined as above, but when the depot inventory falls below the reorder level the depot enters a rationing mode in which it fills base orders only partially to spread the risk of customer back orders across all bases. The depot remains in the rationing mode until depot on-hand inventory rises above the reorder level again.

In the "system myopic" policy depot and base order quantities are optimized considering the interactions of costs and policies between the depot and its bases and among the bases themselves. This policy "sees" or considers a two-echelon system instead of evaluating each echelon independently.

b. Significance: The study results indicate that system myopic policy alternative is significantly better than allocation inventory policy and the allocation inventory performs better than current USAF EOQ inventory policy.

The results of this follow-on study differ from the results of the previous study (reported September 1976 Semiannual) which used a very small sample. The results of the simulation do not permit unqualified conclusions because a "nonstationary" of the policies emerges. Follow-on work is under way to validate the results.

*2. Project Number C-2-14-77. "An Improved Method of Forecasting Demand for Air Force Logistics Command EOQ Items Based on Aircraft Flying Hour Programs," Major E. L. Smith. Air Command and Staff College. Advisor: Major Riske.

a. Summary: This study examined the relative effectiveness of two methods to predict demand for Air Force Logistics Command (AFLC) C-141 Economic Order Quantity (EOQ) items. The author evaluated the present system for predicting demand used by AFLC for EOQ items, the straight-line averaging of the previous eight quarters demand history. The AFLC approach was compared with the prediction based upon intended use of weapon systems (in terms of flying hours). The author randomly selected 372 C-141 EOQ items for the test using the statistical technique Wilcoxon Matched-Pairs Signed-Ranks test. The Wilcoxon approach considers the relative magnitude as well as the direction of the difference in predicting demand rates. The approach enabled the researcher to identify which prediction method is more cost effective and to what extent. Supply support effectiveness was not evaluated.

b. Significance: The research indicated that the flying hour method for predicting demand on EOQ items is convincingly better than straight-line averaging (confidence level in excess of 95 percent). The flying hour method is 8.2 percent more cost effective than the straight-line averaging for C-141 EOQ items. A strong probability exists that the flying hour method should be considered for implementation. Further tests need to be conducted for other weapon systems as well as items associated with more than one type/model/series weapon system.

*3. Project Number C-2-15-77. "A Comparative Analysis of the D041 Single Moving Average and Other Time Series Analysis Forecasting Techniques," Captains J. Brentley and D. Loreman. AFIT. Advisor: Major J. Pearson.

a. Summary: This study examined the forecasting technique used in the Air Force Logistics Command (AFLC) for determining requirements in the reparable asset management system. AFLC manages spares according to the provisions of the Recoverable Consumption Item Requirements System (D041), a computer-based inventory control system. Spares under this system are recoverable items coded with an Expendability-Recoverability-Reparability-Code (ERRC) of XD, which indicates that the spare is reparable at the base or depot level when necessary. Spares constantly move through a cycle of transactions from the supply activity's warehouse, to installation on end item, to removal from a higher assembly after failure, through a repair facility, and then back to the supply activity ready for reissue once again. The effectiveness of the AFLC spares support system depends upon the accuracy of forecasts; therefore, it is imperative that the most accurate forecasting technique available be used. The system currently in use (D041) depends primarily on the weighted moving average technique, specifically a twenty-four month moving average. The researchers evaluated the effectiveness of the moving average method and the exponential smoothing forecasting method. They then compared both methods in order to determine their accuracy and applicability.

b. Significance: The research indicated that there is no statistically significant difference in the expected values of the forecast errors for the moving average or exponential smoothing forecast technique. The present D041 forecasting method inferred a somewhat consistent tendency to over-forecast. However, the exponential smoothing forecast inferred a tendency to under-forecast.

SYSTEM REQUIREMENTS MANAGEMENT

Area Manager: Major Lyle W. Lockwood

Objective: To establish a strategy for managing system acquisition requirements that will assure the achievement of acquisition objectives.

Background:

The system acquisition requirements process has long been the topic of high level study and top management, including congressional attention. It is no exaggeration to state that requirements management is one of the most difficult problems facing acquisition managers today. The difficulty is increased by the fact that the term "requirements" is not clearly defined in a systems acquisition context. Consequently, emphasis has centered on two dimensions: (a) the sequence of activities in the acquisition process, and (b) the institutional arrangements, especially review and decision levels such as DSARC.

Recent efforts have resulted in improved understanding of the sequentially-oriented process. Top management's attention has been concentrated on refinements of organizational element roles in reviewing and evaluating acquisition requirements. The general flow of requirements has been judiciously charted. Directions and branches of flow have been established. Management controls and reviews have been defined and designed into the process like valves, gauges, and spigots in a pipeline. In total, these efforts have done much to clarify and establish control of the process.

However, the requirements process and related management controls need a better means of addressing the varied contents of the requirements pipeline if they are to realize their intended potential.

System acquisition requirements can be divided into the following categories: (a) mission requirements, (b) operating characteristics, (c) design standards and specifications, (d) management system standards and specifications, (e) legal obligations, and (f) programming requirements. This categorization of requirements adds a third dimension to the requirements process flow--substance.

Defining and satisfying each requirement category clearly consumes both resources and time, and these costs should be estimated and compared with the benefits derived from each category of requirement.

Significance: Although the requirements process and its organizational dimension are dynamic, addition of a third dimension--requirements categories--

to the process provides a framework to: (a) identify the total set of requirements that will be applicable/not applicable to an acquisition program, (b) determine the appropriate program phase to introduce requirement combinations applicable to a program, (c) assign the appropriate organizational element responsibility for evaluating a given set of requirements within a category, (d) assign cost and worth values to each requirement, and (e) analyze trade-offs and resolve conflicts for short-range versus long-range costs/benefits of requirements. There needs to be a unifying conception and classification system to improve management of acquisition requirements.

Research Opportunities:

1. Is the aforementioned classification of requirements valid and complete?
2. What is the form, cost, and benefits of each category of system acquisition requirements?
3. What is the appropriate acquisition phase to introduce each category of system acquisition requirements?
4. What are the costs and benefits of the specification tailoring process as applied to design standards and specifications? Can the process be expanded to other requirement categories?

Projects Completed(*)/In Progress:

*1. Project Number C-3-1-77. "Acquisition of Embedded Computer Software: A Descriptive Model," Captain Jerry K. Watson. Graduate School, University of Missouri-Rolla. Advisor: Dr. Yildirim Omurtag.

a. Summary: The objective of this study was to provide a descriptive model of the Embedded Computer System acquisition process. An Embedded Computer System, as used within DOD, is a system which is dedicated to a specific function within a larger (and mobile) system whose primary function is not data processing and which consists of hardware and software designed and developed simultaneously. The study recognizes that methods, procedures, rules, and regulations are dynamic in nature. It, therefore, depicts the Embedded Computer System acquisition process in its state at the time of the study. Software is placed in perspective with hardware, normally troublesome

term definition and concepts are provided. The primary emphasis on the model is on the interrelationships between hardware and software development for Embedded Computer Systems. The model was developed from literature review and a validation within a major Air Force System Program Office.

b. Significance: The study is intended to be of assistance to those responsible for managing acquisition and development of solutions to many of the problems when acquiring Embedded Computer Systems. The study can serve as a source document for system managers. The study attempts to present a balanced view such that, concurrent with elevating the status of software to a major concern, the importance of hardware would be maintained.

*2. Project Number C-3-2-77. "An Evaluation of Contract Modification Instruments," Captains James P. Martin, Harold K. Prigmore, and Bonnette L. Sholley. AFIT. Advisor: Lieutenant Colonel Larry L. Smith.

a. Summary: Contract modifications are a major part of the administrative and technical workload for managing contracts. In the case of some major acquisition programs there may be more than 2,000 contract modifications. Some research efforts have studied cost growth as a function of changes and modifications; however, little has been done to analyze the instruments used to accomplish these.

The purpose of this study was to determine which modification instrument was preferred and which was considered most efficient in terms of flexibility, manageability, cost effectiveness, and timeliness.

The types of contract modification instruments evaluated were: unilateral change order issued under the authority of the changes clause or under provisions other than the changes clause, bilateral supplemental agreements under the authority of the changes clause or under provisions other than the changes clause, bilateral agreements for performance outside the scope of work, and constructive change orders.

Usable questionnaire responses were received from 194 Air Force, Army, Navy, and Defense Logistics Agency personnel attending procurement management courses at the Continuing Education Division, AFIT, Wright-Patterson Air Force Base, Ohio. Analysis indicated

that bilateral supplemental agreements under authority of the changes clause was the most preferred and the most efficient procedure; however, the unilateral change order was most timely. Minor exceptions to this conclusion are detailed within the report.

The survey findings were validated by reviewing 75 actual contract modifications at two agency locations. Corollary findings presented are: twenty-three percent of DOD personnel attending the courses did not have the required prior procurement experience, the procurement career field appears to have a large number of "cross-trained" personnel, nearly half of the modifications were for price changes between \$10,000 and \$1,000,000, over one half of the modifications were for specification changes, there appears to be a lack of understanding of the scope of the changes clause, and a significant portion of respondents did not know the type of contract modification instrument preferred by their agency.

b. Significance: This study is a descriptive initial examination of the contract modification process. The report can serve as a starting point for both present managerial actions and follow-on study. Management actions implied are to evaluate: (a) practices regarding the personnel structure of the procurement field and (b) the selection process for personnel attending procurement management courses. For follow-on study: what are the reasons for specification changes, how do other federal agencies manage contract changes, and what is the contractor's view of the contract modification process?

BUSINESS STRATEGY: All processes involving the establishment of business management plans, contractual relationships, and the alignment of specific Air Force functions involved in establishing a business relationship with the private sector.

ROLE OF THE CONTRACTING OFFICER

Area Manager: Captain Peter J. Perkowski

Objective: To provide the knowledge base needed to increase the effectiveness of Air Force contracting officers.

Background: A proliferation of legislation and regulations, evolution of new organizational concepts, and changing technological and socio-economic factors have combined to limit the application of a contracting officer's judgment. It has been stated that the objective of a contracting officer is to buy with the least risk of criticism, instead of buying with efficiency and effectiveness. The Commission on Government Procurement stressed the need for allowing contracting officers to exercise business judgment in representing the Government's interest and for assuring that authority is exercised by qualified individuals.

Significance: Today's business environment, increasing weapons system acquisition and support cost, and tight fiscal constraints mandate that contracting officers be highly qualified and properly motivated. The apparent loss of contracting officer authority and the associated loss of confidence in procurement itself makes it difficult to attract highly motivated people to the field.

Projects Completed(*)/In Progress:

*1. Project Number A-1-10-77. "Base Procurement Handbook," Majors Lamoyne G. Buser and Richard A. Wisler. Air Command and Staff College. Research Advisor: Lieutenant Colonel Al Weisman.

a. **Summary:** This handbook provides information based on the "lessons learned" by experienced procurement officers. Helpful management hints address the key aspects of the base procurement mission. The handbook explains and provides advice on customer and vendor relationships, inspections, training, the role of the contracting officer, contract administration, the Customer Integrated Automated Procurement System (CIAPS), and how to manage people. References are included at the end of each chapter.

b. **Significance:** The handbook is an excellent guide on how to manage base procurement activities. It can also be used by managerial, supervisory, and buying personnel engaged in R&D, central and systems procurement. The handbook is also ideal for use in the classroom as a textbook or a reference document.

*2. Project Number A-1-11-77. "Personal Characteristics of Air Force Contract Negotiators," Captains James G. Bearden and John C. Chipman. AFIT. Advisor: Major Dale R. McKemey.

a. **Summary:** This research rank-orders a list of 27 personal characteristics which are perceived to be attributable to successful Air Force contract negotiators. Surveys were sent to three major Air Force Systems Command organizations and distributed to selected, experienced negotiators. The 27 personal characteristics were scored by each respondent. Findings were then correlated among the three organizations to determine if there was a consistent rank-ordering. The results did show high correlation. Interestingly, the Armed Services Procurement Regulation (ASPR) emphasizes the evaluation of experience, training, and education in selecting contract negotiators. However, the results of the study show that education is one of the lowest ranking characteristics while self-confidence, adaptability, rationality, and verbal skill are considered the highest.

b. **Significance:** Since DOD negotiators operate under the same rules (ASPR) and usually all represent the "buyer" side of the market for the Government, the research findings appear to be applicable to the entire DOD. However, due to a lack of adequate measures of these characteristics, their use should be limited to subjective evaluation and consideration in selecting contract negotiators. Utilization of the characteristics for negotiator training, however, should be maximized and encouraged by supervisors and instructors.

*3. Project Number A-1-12-77. "The Impact of the Legal Doctrine of Apparent Authority Upon DOD Contractual Activities," Captain Thomas A. Boynton. AFIT. Advisor: Colonel Robert J. Lucas.

a. **Summary:** This thesis evaluates the legal doctrine of apparent authority, in terms of its meaning, its history, and its applicability to DOD contractual activities. The study:

(1) Outlines concepts and legal precedents underlying the law of agency.

(2) Examines the doctrine of apparent authority, its development, underlying principles, and implications in the private sector.

(3) Discusses the traditional view which holds that the doctrine of apparent authority does not apply to the Government. Includes key court

decisions and a treatment of the philosophies underlying this tradition.

(4) Identifies and presents the source and means of delegating express actual authority.

(5) Examines the grounds for the nontraditional belief that the U.S. Government can be bound by the unauthorized acts of its agents or by agents with other than actual authority.

(6) Presents conclusions and recommendations.

b. Significance: This study is a "must" for all those in the procurement/acquisition function who interface with Air Force and DOD contractors and their representatives. It can also be used in Air Force or DOD procurement, project management, and contract law courses. Reading this study should result in a better understanding of the issues involved in the laws governing agency. This increased understanding should, in turn, better guide Air Force and DOD personnel from inadvertently committing the Government.

*4. Project Number A-1-13-77. "Participation in Source Selection--A Case Study," C. Patrick Carnes. Defense Systems Management College. Advisor: Dr. Joseph Hood.

a. Summary: This study describes the source selection process for a program which does not satisfy the various criteria required to be a designated DSARC program. The initial portion of the study discusses the history of the program in terms of the generation of the requirement document by the operational command and the assignment of the program to one of the acquisition agencies of the Air Force. The report then considers the preparation of the various documentation, such as specifications, data requirements, management and source selection plans, and a request for proposal. The majority of the study describes the source selection process and the difficulties encountered. Appendices are included in the report which provide: acronyms, examples of evaluation areas, items, factors, and an evaluation standard; a numerical scoring scale; and a source selection schedule. Several conclusions and recommendations suggest how the process can be made more efficient and less time consuming. The recommendations include revising AFM 70-6 to: (a) provide a better description of the deficiency reporting process, and

(b) reconcile wide differences in proposed costs when offerors have submitted proposals which have been ranked of equal technical acceptability. The author also recommends that the source selection process and organization be streamlined by eliminating or modifying the functions of the Source Selection Advisory Council (SSAC).

b. Significance: The experiences detailed in this study will be helpful to Air Force and DOD personnel scheduled for source selection duty. The study is excellent for provoking classroom discussion or for providing background information prior to conducting a mock source selection.

ACQUISITION COMMUNICATIONS

Area Manager: Captain Ray E. Fellows

Objective: To improve the communication process between the Air Force and potential contractors.

Background: This research area addresses the multifaceted problem of communicating Air Force requirements to potential contractors and the procurement community (legal staff, administrative staff, etc.). Solicitation documents must be adaptable to a variety of different procurement types (systems, central, or base). In the case of RFPs/IFBs, solicitations must also be contractually correct. The policies, procedures, and documents available to contracting officers are numerous. The effectiveness and appropriateness of these must be evaluated. Communication theory is also of concern, i.e., the purpose of solicitations is to facilitate two-way communication. On the one hand, Air Force requirements must be clearly communicated to prospective offerors; on the other hand, each offeror's response must be understood by the contracting officer. Finally, the behavior of the personnel, both Government and contractor, in this communication is considered an important aspect of this research area. The training, experience, motivation, and response patterns all contribute significantly to the success of the acquisition communication process.

Projects Completed(*)/In Progress:

*1. Project Number A-2-2-77. "Negotiation Guide for Air Force Contract Negotiators and Managers," Major John R. Fisher. Air Command and Staff College. Research Advisor: Major Art Machado.

a. Summary: This research study describes the act of negotiating in general terms, but it also can be used as a guide to preparing for negotiations. It specifically describes the negotiation process in three primary areas in which negotiations occur in the Air Force. These are procurement contract negotiations, collective bargaining contract negotiations, and negotiating as managers. The study outlines helpful ideas for each of these situations. The study also provides a good bibliography of the mechanical aspects of negotiating.

b. Significance: This study can be used as a guide for preparing for negotiations. It should be useful to contract negotiators and to any individual manager who must resolve conflict.

*2. Project Number A-2-3-77. "The Dynamics of Communication Between the Procurement and Contract Administration Offices in the Air Force," Richard D. Claussen, University of New Mexico. Thesis Chairman: Dr. Albert Rosenthal.

a. Summary: This study examines the degree of administrative effectiveness between procurement and contract administration pricing offices involved in major weapon system acquisition. Through the use of questionnaires, the author measured the effectiveness (through the perception of "line employees") of oral communication, memoranda of understanding, and pricing workload schedules. The researcher found that respondents supported the importance of: reflecting tasks in the schedule of pricing workload, allowing sufficient time to perform an analysis, having an adequate communication dialog, and clearly identifying the extent of pricing assistance required. A number of conclusions and recommendations concerning the perceptions of "line employees," employee involvement, memoranda of understanding, pricing workloads, and scheduling are included in the study.

b. Significance: This study contains useful information for the procurement office manager and the Air Force contract management supervisors who are concerned with administering the Air Force contracts. It indicates that the reliability of the schedule of pricing case workload is directly related to task delineation, manhour allocation, and communication and pricing requests. The respondents to the study questionnaire strongly indicated that they felt scheduling the

office workload was not being accomplished. The managers in the Air Force Systems Command (AFSC) divisions and Air Force Plant Representatives' Offices on AFSC contracts can use the results of this study to better understand their employees and make improvements in the administrative effectiveness of their office.

ANALYSIS OF DISPUTES/PROTESTS

Area Manager: Captain Peter J. Perkowski

Objective: To investigate, document, and recommend solutions for problems which have led to protests and disputes.

Background: DOD contractual documents contain provisions relating to protests and disputes. The disputes clause, for example, may apply when the contractor and Government representatives cannot reach agreement on some question of fact. In such cases, the contractor may eventually file an appeal with the Armed Services Board of Contract Appeals (ASBCA). The Air Force Logistics Command (AFLC) Judge Advocate is responsible for reviewing Air Force contracting officer's final decisions and defending such cases before the ASBCA. Review of past protests and dispute situations to determine procurement practices that require improvement will add to our problem prevention capability and will assist in pinpointing topics suitable for future research effort.

Projects Completed(*)/In Progress:
None

IMPACT OF FOREIGN MILITARY BUSINESS

Area Manager: Captain Peter J. Perkowski

Objectives: Examine, define, and understand the implications of foreign military business (FMB) on the U.S. defense acquisition process. From such study, extract ideas and recommendations directed toward the management policies and procedures used to cope with Air Force involvement with FMB.

Background: The FMB area can be considered to include three parts: (a) foreign military sales (FMS), (b) international cooperative programs, and (c) grant aid. These three parts describe major types of FMB activity. Nevertheless, the AFBRMC feels it is necessary to apply further effort to

organization of the research area to arrive at the major issues that currently impact the defense acquisition process. Specifically, the FMB area can be considered to incorporate the following topics which transcend each of the three parts discussed above:

a. Conflict Resolution Process. The thrust of this topic is managerial in nature, i.e., the objective is to manage conflict. The major issue concerns negotiations involving memoranda of understanding, price and availability data, and letters of offer and acceptance.

b. Impact of FMB on Procurement Policy and Procedures. Organization for effective procurement support where international participation is involved is a major issue under this topic. Other issues include the application of various statutes, ASPR provisions, etc., to FMB situations; acquisition planning when requirements other than those of U.S. forces are included.

c. Management of International Programs. Many major issues fall under this topic: coproduction and codevelopment; rationalization/standardization; offset management (incorporating procurement from foreign sources); technology transfer and foreign disclosure; and binational, multinational, or consortium management efforts.

d. Logistics Support. Inevitably, each of the three aspects of FMB result in a requirement for logistics support. Thus, a major issue is the cooperative logistics support system maintained by AFLC. Elements of this issue include support alternatives, financial management, and such things as transportation and communication. Also involved is the area of AFSC/AFLC interface and the subjects of product support and the engine Component Improvement Program (CIP).

Significance: Sales of military items are of interest because of the effort required to cope with the increasing dollar value and number of actions involved and the ensuing impact on the acquisition process. International cooperative efforts such as coproduction and codevelopment promise to be in demand by countries desiring to reduce foreign exchange outflow while upgrading their technological capability. Further, projects of the magnitude of the F-16 pose substantial management challenges. The final part, grant aid, is of declining importance, but may retain residual interest due to the inability

of some allies to transition to the purchasing mode for satisfying defense needs.

Projects Completed(*)/In Progress:

*1. Project Number A-4-8-76. "Foreign Military Sales Product Support: An Exploratory Study of the Support Purchased as Part of the Initial Acquisition Effort for the F-5 Weapon System," Captain J. P. Dutcher. AFIT. Advisor: Lieutenant Colonel William C. Letzkus.

a. Summary: Foreign Military Sales (FMS) programs are complex and difficult to manage. One reason is due to a lack of understanding and definition to implicit product support and its cost allocation relative to the hardware acquisition effort. By studying the F-5 weapon system program, the author developed a set of support definitions and concepts which can be used during the life of any FMS weapon system program. Support problems are identified, and suggested solutions are provided. Some of the problems identified include: support cost allocation problems, the matching of support benefits with costs, and problems associated with funding support efforts.

b. Research Findings: Prior to the study, no commonly accepted, concise definitions or subdivisions of product support were available. Hence, the author classified product support as being: predelivery or post-delivery, production or field support, and explicit or implicit support. The most costly area of product was found to be postdelivery field support. This support includes tasks directed at keeping systems operational, improving systems, improving maintenance, and correcting deficiencies. The following three major F-5 problems are explained in the study. It is assumed that other FMS programs have the same or similar problems:

(1) Postdelivery field support costs increase as delivery rates decrease.

(2) Field support costs do not match the benefits received by FMS customers. This stems from current practices in allocating support costs to production units.

(3) The duration of post-delivery field support is difficult to determine. Estimates depend on the expected life of a system.

The study concludes that there is no centralized authority within the Air Force responsible for FMS support management. The author recommends that the responsibility for FMS postdelivery field support be assigned to the Air Force Logistics Command.

c. Significance: This study establishes a framework whereby product support and the allocation of product support costs can be identified, examined, classified, and controlled.

*2. Project Number A-4-9-77. "FMS Costing--A Reverse Government Subsidy," Major Jack H. Gambill. Air Command and Staff College. Research Advisor: Lieutenant Colonel James L. Tait.

a. Summary: This study investigates U.S. Government Foreign Military Sales (FMS) policies and procedures regarding payment terms and unallowable costs to determine if U.S. contractors unnecessarily subsidize FMS procurements. The author also addresses whether FMS policies are in accordance with generally accepted accounting principles and the feasibility of proposed alternatives to current policies on payment terms and unallowable costs.

b. Significance: This study details, for policy consideration, six major problem areas voiced by the Aerospace Industries Association of America, Inc. (AIA). The study can also be used as a reference guide by U.S. Government price analysts and procurement and program management personnel. The study contains a wealth of information on ASPR, FMS provisions, FMS procedures, financing considerations, and detailed costing information.

*3. Project Number A-4-10-77. "Role of the Program Office in Foreign Military Sales," Major John D. Henderson. Air Command and Staff College.

a. Summary: This study formulates an overall course of action for the Program Office to follow in dealing with Foreign Military Sales (FMS) cases. The study also addresses:

(1) The importance of trading with foreign countries.

(2) FMS procedures and directives originating externally to the Program Office.

(3) The roles of the program manager and staff by highlighting the management and control of FMS programs in the Program Office; and

(4) Possible improved methods of handling FMS cases.

b. Significance: This study highlights the internal structure of a program office and how it can be organized to handle FMS cases. The study provides general background and guidance for program managers inexperienced in managing FMS cases. It is an excellent overview or supplement to the studies performed by McChesney and Materna. This study is ideal for those who need to become quickly familiar with FMS program management.

*4. Project Number A-4-11-77. "The Air Force Security Assistance Program: Organizing for the Future," Major Gilbert D. Rye. Air Command and Staff College.

a. Summary: This research study explores the organizational interrelationships among the offices within the Air Staff and among the Air Staff, Air Force Systems Command (AFSC), and Air Force Logistics Command (AFLC) for accomplishing the security assistance mission. Two aspects of organizational interrelationships are investigated. The first area deals with organizational alignment; i.e., the adequacy of the Air Force's current organizational structure to successfully accomplish the security assistance mission. The second area addresses the degree to which required functions and responsibilities are being performed by the proper organizations. Utilizing the preliminary drafts of two unapproved FMS/Security Assistance studies as a baseline, the author ultimately provides a chart which summarizes functional FMS deficiencies within specific organizations. These deficiencies stem from inadequate departmentalization, decentralization, and directives. Recommendations are provided.

b. Significance:

This study pinpoints the major internal and interorganizational functions and deficiencies within and between the Air Staff, AFSC, and AFLC in managing FMS and security assistance programs. Although the author could find only three sources of information directly related to FMS organizational problems, this study provides an excellent baseline for decision making by appropriate Air Staff, AFSC, and AFLC personnel.

This study is also an excellent reference document for all those

involved in the FMS process. Procurement and program management personnel will especially find this study interesting because it details "who is responsible for what" at the Air Staff, AFSC, and AFLC during the FMS/Security Assistance acquisition process.

*5. Project Number A-4-12-77. "Cost Implications of Accounting Practices of the European Consortium Countries," Lieutenant Colonel William C. Letzkus. AFIT.

a. Summary: This study identifies some of the accounting practices within the four European members of the F-16 Consortium (viz, Belgium, Denmark, Netherlands, and Norway) which differ from U.S. accounting practices. The possible impact of these different practices on "costs" reported to the F-16 prime contractor and/or the F-16 Program Office is assessed. A brief overview of the international accounting environment is followed by a summary of the major potential influences on selected "costs" due to differences in accounting or legal practices and requirements. The "costs" reviewed are depreciation costs, pension costs, and the use of reserves. Due to its intimate relationship with depreciation, the area of capitalization of fixed assets is also examined. Appendices provide a more detailed discussion of the accounting issues for each of the four European members of the consortium. Each of the appendices "stands by itself," i.e., one appendix does not refer to a second appendix for supporting narrative.

b. Significance. This study was written to provide information to the F-16 Program Office. However, an assessment by the BRMC indicates that this report is also applicable to all Government personnel involved with other cooperative or FMS procurements. It is particularly useful to Defense Contract Audit Agency personnel and DOD price analysts in analyzing cost proposals and monitoring costs on international cooperative programs such as the F-16, or any procurement involving a non-U.S. subcontractor.

*6. Project Number A-4-13-77. "Test and Evaluation Conducted for Foreign Military Sales Programs," Major Gordon W. Fox. Air Command and Staff College. Research Advisor: Major Ned Nelson, Jr.

a. Summary: This study addresses the adequacy of USAF weapons acquisition

test and evaluation (T&E) procedures to FMS development programs. After explaining the various types of T&E and relating them to FMS programs, the author provides a number of conclusions and recommendations. They include:

(1) Development, test and evaluation (DT&E) management can involve a USAF major command representing a foreign customer, a joint contractor/USAF test team, or foreign pilots as members of the test team;

(2) Air Force Regulation 80-14 should be revised. It does not provide sufficient guidance for operational T&E in FMS programs because essential differences exist. The differences depend on when the production decision is made and the desires and capabilities of the customer;

(3) A new concept called operational assessment should be developed. It combines the essential features of initial operation test and evaluation (IOT&E) and follow-on test and evaluation (FOT&E). As a minimum, this concept will identify operational deficiencies and provide an estimate of the system's military utility; and

(4) Basic test and evaluation provisions, including those for operational assessment testing, should be included in the Letter of Offer for a development program.

b. Significance: Within the USAF, new weapons acquisitions incur extensive T&E before and while the system is introduced into operation. This allows sufficient time for most deficiencies to be identified and corrected before operational units receive the equipment. However, if customer nations purchase undeveloped products, there may not be sufficient test time to thoroughly check the system until after delivery has been made. Hence, for FMS development programs, T&E must be sufficient to identify and correct deficiencies in dependable equipment which is logistically supportable. The study provides System Program Office personnel with information on how to conduct T&E for exclusively FMS programs and to what extent T&E should be done.

*7. Project Number A-4-14-77. "An Analysis of the F-16 Offset Commitment," Captains Arthur S. Leach and Dennis H. Majkowski. AFIT. Advisor: Lieutenant Colonel William C. Letzkus.

a. Summary: This study presents an overview of the problems associated with managing the F-16 offset commitment with the four European consortium countries. The potential problems addressed in the study deal primarily with the explicit and implicit definitions of the offset agreement contained in the Memorandum of Understanding (MOU) and the U.S. requirement to document and report offset achievements. The purpose of this study is to identify potential difficulties that may occur during the life of the F-16 program. Although specific recommendations are included throughout the study, the authors' intent was not to develop possible solutions.

The study begins with a review of previous coproduction agreements and certain aspects of U.S. laws and regulations that apply to Foreign Military Sales. Following a description of the F-16 program, the authors summarize the major points of the MOU, with emphasis on the offset agreement and its requirements. The bulk of the study addresses the problems associated with the requirements of the offset agreement.

Appendices are included which provide definitions, acronyms, and a copy of the F-16 Coproduction Participation Plan.

b. Significance: This study provides insight into offset management by identifying potential problems to F-16 program managers and to future programs that will involve offset commitments and coproduction. Careful organization and thorough understanding of these problem areas will aid both contractor and USAF program managers to avoid them when possible and to overcome them when necessary.

c. Note: This study is classified FOR OFFICIAL USE ONLY. Requests for this study must be submitted in writing to the BRMC when ordering, explain reason for wanting the study and list your address and telephone number.

*8. Project Number A-4-15-77. "Non-standard Support Concepts in USAF-Managed Security Assistance Programs," Major James D. Picard, USA, and Captain Michael J. Phalen, USAF. AFIT. Advisor: Dr. Leslie M. Norton.

a. Summary: An increasing number of FMS customers are purchasing items and subsystems which are not procured

for USAF use. Current USAF policy dictates that these nonstandard items will be supported when directed by OSD. Recently there have been significant efforts to improve and standardize this support. This study identifies and analyzes USAF efforts to improve nonstandard support.

b. Significance: This study is especially useful to program management and HQ AFSC and AFLC personnel who are involved in the procurement and management of nonstandard support items. This study provides an overview of the history of nonstandard support; definitions; two case histories on how nonstandard support problems were handled; a model for evaluating nonstandard item support requirements; and a number of recommendations and conclusions for consideration by DOD, USAF, and DSAA decision makers. Suggestions for future research are provided.

*9. Project Number A-4-16-77. "Foreign Military Sales Weapon System Cost Estimation Procedure: A Case Study of the F-4 Fighter/Attack Aircraft," Captains Charles Flowers and Laurent J. J. Legault. AFIT. Advisor: Dr. Leslie M. Norton.

a. Summary: This thesis examines the cost estimation procedure used by the F/RF-4 systems program, Financial Directorate, to prepare a price and availability (P&A) estimate for Foreign Military Sales (FMS) requests. The study provides an analysis of the coordination process involved in an F/RF-4 P&A request, beginning with the foreign country and concluding with the Aeronautical Systems Division (ASD) of the Air Force Systems Command. The study also includes a detailed analysis of the data base for the computer algorithm used by the Financial Directorate. The algorithm assures that real-time component costs are included in the P&A estimate. Conclusions from this research indicate that the data base allows continuous updating of cost components. It also enables instant modification of cost estimates in response to country inquiries arising from changes which occur during formal price negotiations.

b. Significance: This is the first study that the BRMC is aware of which ties in the P&A process with a specific weapon system program. It provides procurement pricing, cost estimating, and project management personnel with information on the P&A process, a building block approach to

cost estimating and a computer program for tracking and updating costs. Future studies are recommended for researchers interested in FMS cost estimating and the feasibility of a centralized price and availability directorate within the ASD.

*10. Project Number A-4-17-77. "An Analysis of a New Cash Payment Plan for Foreign Military Sales to Iran," Captain Jimmey R. Morrell. Air Command and Staff College. Advisor: Thomas C. Padgett.

a. Summary: This research study discusses the U.S. transition from a program of military assistance to the current large scale Foreign Military Sales (FMS) effort, focusing specific attention on Iran. The primary objective of the study is to analyze the normal payment system for cash sales and a proposed new cash payment system for Iran. Political and economic benefits are the criteria used to analyze the two payment systems. Possible disadvantages of the new payment system are discussed. However, the author concludes that the proposed new payment method represents a significant improvement and recommends its implementation.

b. Significance: This easily readable study is highly recommended for those concerned with the FMS cash flow process, and program control and financial management personnel who monitor and manage funds on weapon system programs for Iran and other FMS countries. For those interested in Iran, arms transfers, and FMS, the study contains tables and appendices which provide information such as:

- (1) Statistics on arms transfers,
- (2) Trends in FMS and Grant Aid (1964-1975),
- (3) Iran's past-due debts to the U.S.,
- (4) Types of FMS financing,
- (5) The economic benefits of FMS, and
- (6) Data on Iran.

PROGRAM MANAGEMENT: The processes of planning, organizing, and controlling internal Air Force activities to insure that contracted program needs are satisfied.

BUSINESS MANAGEMENT SYSTEMS

Area Manager: Captain William L. Glover

Objective: To determine the management information systems needed by today's program managers.

Background: A number of management systems exist which a program manager can (or must) use in an acquisition program; however, not all are appropriate for a given situation. Such methods as C/SCSC, milestone, network analysis, and periodic program reviews are commonplace, yet programs using them continue to experience mixed results. Problems in the area can generally be viewed from two perspectives. First, what is (and how do we achieve) the proper balance between system need, implementation and maintenance effort, and desired results? Second, what are the limits of a system's capacity for satisfying management needs across a variety of programs and for multiple layers of decision-makers?

Projects Completed(*)/In Progress:

1. Project Number B-1-7-76. "Application of the Cost Performance Forecasting Concept and Model (ASD Cost Research Report 117) to Non-Air Force Data," Mr. Arthur Karsch. ASD.

a. Summary: Cost Research Report (CRR) 117 presents a cost forecasting method with the objective of forecasting estimates at completion (EACs) each month, using data from Cost Performance Reports. The CRR 117 model was developed based on data from programs managed by the Aeronautical Systems Division. This project will apply the model to data from the Army Heavy Lift Helicopter program to determine the validity of applying the model to non-Air Force systems. This project was previously reported in the 30 September 1976 Semiannual Business Research Report. Completion is expected in Spring of 1978.

*2. Project Number B-1-8-77. "A Cost Performance Forecasting Model,"

Major Daniel E. Busse. Air Command and Staff College and Auburn University. Research Advisor: Major Claude Mitchell.

a. Summary: The objective of this research effort was to develop a program management tool for forecasting estimated cost at completion (EAC) using elements of contract performance reports (CPRs) as inputs. The forecast, in turn, can be compared to the contractor estimate of final cost. To meet this objective, the researcher used differential calculus to derive a model that provides a forecast of the EAC. This forecast can be used with other program information to verify current and forecasted short-run contractor performance estimates. The research report includes a simple algorithm and an example of how to apply the model using CPR data and a desk or hand calculator.

b. Significance: The concept used by the researcher implies that expected program progress, at least in the short run, is related to recent past performance and current status. Therefore, the model should be used as a short run, attention directing tool. The model is simple and provides the program manager with an efficient method to readily cross-check contractor estimates using CPR data as inputs.

*3. Project Number B-1-9-77. ASD Cost Research Report No. 132, "A Production Study Sequel to the Cost Performance Forecasting Concept and Model," Mr. O. Arthur Karsch. ASD.

a. Summary: This report demonstrates the ability of the "Cost Performance Forecasting Concept and Model" to forecast estimates at completion (EACs) each month utilizing data available in production type cost performance reports (CPRs). The model concept was documented previously as Cost Research Report (CRR) No. 117 and published in November 1974 by the Directorate of Cost Analysis, Comptroller, Aeronautical Systems Division, Wright-Patterson AFB, Ohio. CRR #117 demonstrates the model utilizing data available in R&D type CPRs.

In this report two unrelated historical samples were used and treated independently in comparing the consequences of various forecasting methods. One sample is a production aircraft case and the other sample is a production missile case. The forecasting methods used in each case are the

linear extrapolation of percent cumulative cost variance and the unconstrained and constrained regression analysis applied to an exponential relationship. All sample data and computed data are contained in this report. The computation procedures and resource references that were used are identical to those described in CRR #117.

The report shows that the constrained exponential method offers the forecaster an improved method of final cost forecasting and demonstrates the use of measured subjectivity as a management input on production type programs.

b. Significance: This study is significant because it is an example of applying existing cost performance tools to new areas. Models are often developed for a specific application, and progress in expanding their application ceases when such expansion could benefit Air Force program managers. Using a common approach should help maintain continuity during various phases of acquisition, thereby strengthening management systems.

*4. Project Number B-1-10-77. "Lessons Learned in USAF Weapon System Acquisition Management: A Case Study Approach," Captains Leon-Girard R. Ketchum and Burton E. McKenzie. AFIT. Advisor: Lieutenant Colonel John R. Adams.

a. Summary: This thesis presents 15 case studies that describe a number of the management problems that typically occur throughout weapon system acquisitions. Seven aspects of weapon system acquisition are addressed by the cases: procurement planning and selecting acquisition strategy, system program office personnel, managing program changes, support planning, managing total system integration, managing production, eliminating contract/hardware deficiencies, and transferring system responsibility. In addition to the cases, the authors provide a wealth of information on the phases of the acquisition process, functions performed within each phase, and the roles and relationships between various DOD agencies during the process.

b. Significance: This study was written to make Air Force acquisition personnel aware of past weapon system acquisition experiences to help preclude costly management errors in the future. The cases included in the study are designed for classroom support

use. They contain introductory theoretical material, classroom procedure suggestions, actual cases, and instructor guidance. The cases could be readily adaptable to courses taught at the Air Force Institute of Technology, the Industrial College of the Armed Forces (ICAF), and the Defense Systems Management College, for example. This study is also an excellent guide or reference for system program personnel involved in, or responsible for, planning or managing the various phases of the acquisition process.

SYSTEMS COST ESTIMATING

Area Manager: Captain William L. Glover

Objective: To improve the validity, accuracy, and reliability of cost estimates.

Background: The traditional approach to developing cost estimates is to extend accounting data by statistical methods. Using historical accounting data, which statistically captures many dynamic variables such as economic conditions, effects of post-estimate controls, etc., causes many problems when trying to develop valid, accurate, and reliable estimates. Recent research has tried to recognize uncertainties and lack of information by applying the concept of entropy to cost estimating. Research suggests that cost and risk analysis based upon technical unknowns can be combined to reduce estimating errors.

Significance: Since cost estimates have a variety of applications, it is readily apparent that their improvement will have significant impact on the system acquisition process.

Projects Completed(*)/In Progress:

*1. Project Number B-3-9-77. "The Air Force Cost Estimating Process: The Agencies Involved and Estimating Techniques Used," Majors Edwin M. Lewis and Eugene D. Pearson. AFIT. Advisor: Lieutenant Colonel John R. Adams.

a. Summary: This research effort attempted to describe the overall cost estimating process used by the Air Force in the acquisition of new major weapon systems. To accomplish their objective, the researchers developed a descriptive model of the process and interviewed 80 cost estimators to gather data to determine if the model reflects the

"real world" of cost estimating. The study also describes how the model relates to the Defense System Acquisition Review Council (DSARC) decision process. The researchers found that cost estimates are often optimistic to advocate systems to the DSARC and Congress. Further, the estimating process lacks adequate data bases, has no formal feedback mechanism concerning accuracy, and provides very little feedback on how program changes affect estimates. A further finding was that there was no consensus among the estimators for the meaning of "accuracy" even though they recognized the importance of "accurate" estimates. The researchers conclude that the literature available to cost estimators does not reflect the "real world" of estimating and that a major cause of the confusion about "accuracy" is the lack of a standard for defining and measuring "accuracy." The researchers recommend that a publication be developed to describe the estimating process and outline where specific organizations fit into that process. The publication should also define "accuracy," provide guidance for measuring "accuracy," and establish a feedback mechanism so estimators can track performance. Finally, such a document should also include a compendium of terms and provide guidance for establishing a standard data base for developing estimates.

b. Significance: System cost estimating has been studied by many researchers. However, most studies address specific models or procedures that are used to generate estimates of system cost. In contrast, this thesis provides a description of the overall Air Force cost estimating process for all phases of system acquisition, and identifies the key aspects of the process and major strengths and weaknesses.

*2. Project Number B-3-10-77. "A Methodology for Subjective Assessment of Probability Distributions," Captains Anthony S. Grayson and Harold J. Lanclos. AFIT. Advisor: Lieutenant Colonel M. D. Martin.

a. Summary: The objective of this research effort was to evaluate existing techniques for assessing subjective probability and provide a technique to quantify the magnitude of uncertainty in a weapon system development program. The researchers used content analysis to evaluate techniques that appear most frequently in the literature. The criteria used to conduct

the analyses were: ease of application, adaptability, reliability, time, and ease of elimination of personal bias. The results indicated that the Standard Lottery technique best meets the research objective, however, the researchers felt that this result was inconclusive because data sources varied widely. The DELPHI technique is most widely used; therefore, it received the greatest attention in the literature. Further, several of the techniques had little empirical testing.

b. Significance: The study has significance to research and to management because it reveals vague areas in both behavioral and statistical aspects of subjective probability assessments and documents that testing of the various techniques has been fragmentary and lacks consistency. Further testing needs to be done to determine which technique or techniques best apply to weapon system development.

LOGISTICS: Processes of supporting the systems in the operating inventory.

RELIABILITY MANAGEMENT

Area Managers: Major Lyle W. Lockwood and Captain Paul W. Gross, Jr.

Objective: To realize system/equipment reliability that minimizes life cycle cost (LCC) and achieves the required level of system effectiveness.

Background: Reliability is one of the most important operating characteristic parameters of Air Force equipment. Equipment reliability affects operational readiness, inventory levels, procurement quantities, and maintenance resources. The technical, business, and logistics dimensions of reliability are important to the acquisition process. The technical dimension must consider the design, test, and prediction factors which impact upon demonstrating weapon system reliability. The business dimension deals with the cost/benefit analysis for reliability improvement, contractual specification for reliability, and the administration of contractual reliability requirements. The procurement technique of reliability improvement warranty (RIW) is a contract methodology presently being introduced

to improve system reliability. The logistics effects dimensions are concerned with inventory/supply management, maintenance, and transportation changes in the system required to accommodate warranties.

Significance: There is an important need to reduce support costs for military systems to levels which are consistent with funding limitations. The dimensions discussed above are important parameters of system LCC and operational effectiveness, and they can provide fruitful areas for research. The RIW procurement technique needs to be evaluated as a contractual approach to improve reliability.

Projects Completed(*)/In Progress:

*1. Project Number D-1-7-77. "Extended Logistics Models: The Dynamics of Multi-Item Inventory and Repair Systems," Professor Julian Keilson and Mr. Stephen C. Graves. The University of Rochester. Research Manager: Major Lyle W. Lockwood.

a. Summary: Procurement/acquisition of a complex military system requires planning and trade-off analyses at many levels. The author describes a complex military system as an "Extended Logistics System" which is a well-defined configuration of complex equipment, supporting inventory levels of components and modules, supporting maintenance facilities, supporting transportation system between local and remote inventory and maintenance sites, and procedures governing the allocation and shipment of components from remote to local sites. Initial design (or redesign/modification) of a complex military system, i.e., an "Extended Logistics System," requires trade-offs to be made among alternative reliability (failure rates), maintainability (repair rates), and inventory levels in order to achieve requisite cost or system availability, i.e., readiness, objectives.

This initial report describes and critiques the adequacy and state-of-the-art of inventory theory, reliability theory, and systems theory applicable to military procurement procedures and standards to make these trade-offs. Emphasis is concentrated upon developing an approach which overcomes many of the criticisms and shortcomings of current methods. A model is presented which produces dynamic outputs. Results of trade-off options are presented in

terms of system failure time versus static output, i.e., ratios/percentages.

Although the model is described semi-quantitatively in the report, it depends on the mathematics of renewal systems, markov processes, and LaPlace transforms which are detailed in an appendix to the report. The general structure of the model is presented by qualitative discussion and an illustrated example in the report.

b. **Significance:** Two significant findings are highlighted by this report and companion discussion: (1) the value of using dynamic measures of readiness, i.e., availability to evaluate system design alternatives in lieu of static measures, and (2) the inadequacy of available inventory and reliability theory to present a unified theory for design and acquisition decision making.

In an accompanying letter, the authors present the following example that illustrates the importance of using dynamic information for system design and trade-off studies. A squadron must have seven of ten aircraft ready to fly to be considered operationally ready. The expected flying time per aircraft between failures is ten weeks, and the expected repair time per aircraft is one week. A static analysis would yield a system availability of 77.7 percent. A dynamic analysis would show that the mean time the base will stay operationally ready would be 7.18 weeks after a seventh aircraft becomes available and that the mean time for the base to again become operationally ready after dropping to six aircraft available would be 2.06 weeks.

Now suppose there are two available alternatives comparable in terms of usability and cost. Alternative one is to provide the capacity to repair an aircraft in one-half week, and alternative two is to increase aircraft reliability to twenty weeks between failure. A static analysis of either alternative would yield a system availability of 97.6 percent. However, a dynamic analysis would show a mean time of being operationally ready of 28.8 weeks and being not operationally ready of 0.7 weeks for alternative one. A dynamic analysis of alternative two would show a mean operationally ready time of 57.6 weeks and not operationally ready mean time of 1.4 weeks.

This simple example illustrates that static analysis is limited, and dynamic

analysis is required to understand the full implications of design trade-offs and to be sensitive to system design configurations. Further study is planned to refine and validate this concept.

*2. **Project Number D-1-8-77.** "Quantification of Selection Criteria for Reliability Improvement Warranty Contracts," Raymond O. Folse. Louisiana State University. Dissertation Chairman: Dr. William W. Thompson, Jr.

a. **Summary:** Reliability Improvement Warranties (RIW) are viewed as a means to reduce life cycle costs (LCC) and a technique to produce favorable return on investments for Department of Defense acquisition. The objective of this study was to extend the framework available to the Air Force in determining whether to apply a RIW for a specific item. Two quantitative approaches are presented in this report.

One approach defines a model for computing the economic value of a RIW contract. The economic value approach uses the difference between LCC (ten-years) of RIW versus non-RIW to determine savings or loss to the Government. The economic value model, in addition to presenting a logical framework by which an RIW decision can be made, determines an economically optimum warranty period.

The other approach was a multivariate statistical technique of discriminate analysis to classify potential items as either RIW or non-RIW applicable. The discriminate analysis approach is considered exploratory in nature. Its derivation is more complex and larger numbers of actual RIW contract outcomes are necessary to define distribution of key variables. However, a framework for extension has been established.

b. **Significance:** The RIW economic value model gives the acquisition/contracting officer a method for determining the testing of a proposed RIW application. The economic value model can be used to find the optimal or most cost-effective warranty period and can simplify the task of warranty pricing.

*3. **Project Number D-1-9-77.** "An Analysis of the Exponential Function as the Underlying Distribution for Describing Failures in Inertial Measurement Units," Captains Lowell R. Crowe and Levi D. Lowman, Jr. AFIT. Advisor: Mr. Daniel E. Reynolds.

a. Summary: Reliability and failure data on equipment is widely used throughout the Air Force as a basis to project maintenance workload and procurement quantities. Most usage of this data, for simplicity, assumes that failure rates are exponential, aggregates data, or both. The purpose of this study was to determine if the failure rates for three Inertial Measurement Units (FLIP, LN-15, and KT-73) followed an exponential distribution. This study found that the gamma model was better than the exponential for the three units studied when using individual failure cycles. It also found that none of the three populations fit any of the alternative distributions tested when the failure data was aggregated into the most commonly used method, i.e., MTBF equals total operating hours/total number of failures which is valid only when using the exponential model. The study also found that high infant mortality was present following renewal. The presence of infant mortality also conflicts with the assumption regarding exponential failure distribution.

b. Significance: Extended evaluation regarding the traditional practices of aggregating failure data and assuming the exponential distribution may lead to improvements in accuracy of predicting maintenance workload and procurement quantity requirements.

*4. Project Number D-1-10-77. "Realized versus Intended Benefits of Supply Warranties," Major M. Williams and Captain H. Bertram. AFIT. Advisor: Lieutenant Colonel Larry Smith.

a. Summary: The objective of this study was to determine if efficient and effective methods exist for procuring, identifying, handling, storing, allocating transportation costs, and obtaining repair of warranted hardware items. The study was limited to supply and commercial warranties. Reliability Improvement Warranties (RIW) were excluded from the study. Supply warranties are usually included in a Government contract at a specific cost. Commercial warranties are usually provided free of charge by suppliers as customary trade practice. In general, the authors found that current Government regulations and procedures for procuring and administering warranties do not provide for efficient and effective application and enforcement of warranty provisions. The present information systems do not provide information on which items are covered by

warranties. Also little staff attention has been given to supply and commercial warranties.

b. Significance: The researchers provided specific, detailed recommended changes to the applicable sections in directives such as Armed Services Procurement Regulation, Air Force Manual (AFM) 67-1, Air Force Regulation (AFR) 70-4, and MIL-STD 130D which cover warranties. A summary of the changes are:

(1) Make ASPR 1-324 applicable only in instances where specific warranty--supply, commercial, etc.--is requested by purchase request initiator or user prior to contract award and optional when supplied voluntarily without prior knowledge or contemplation by procurement contracting officer (PCO).

(2) Include notice in AFM 67-1 that commercial warranties not specifically called for are exempt from marking and identification criteria applicable to specifically procured warranties.

(3) Make paragraph 4-5, AFR 70-4, mandatory only in cases where specific warranty was requested; optional in other cases.

(4) Revised MIL-STD-130D to provide specific examples of warranty markings similar to MIL-STD-129G, paragraph 5.2.2.10.

*5. Project Number D-1-11-77. "A Methodology for Estimating Benefits of an Aircraft Engine Warranty," Captains Martin P. Dooley and Richard E. Kells. AFIT. Advisor: Lieutenant Colonel Donald R. Edwards.

a. Summary: The objective of this study was to develop a methodology to estimate the life cycle economic benefits of an aircraft engine warranty. In the absence of existing DOD engine warranties, models were developed from the basic structure of a commercial aircraft engine warranty, fundamental warranty theory, classic reliability and reliability growth theory, life cycle cost (LCC) concepts and a simple penalty payment approach. Major assumptions in the methodology were that: warranty theory can be used to estimate achieved reliability, reliability growth is accomplished prior to fleet introduction, LCC methods are applicable to estimate penalty payments and reliability benefits, and engine failure rates are constant during each

year. The developed model was tested by using hypothetical data extracted from Air Force cost and planning factor reports, engine actuarial performance data, summary report of reasons for engine removal, and representative contractor data. Mathematics, logic, and internal consistency were tested; an example of a typical application was presented; and key variables for sensitivity were identified.

b. Significance: The authors concluded that the methodology and models developed in the study can be used to estimate the LCC benefits of an aircraft engine warranty. Based upon the use of hypothetical test data the authors also concluded that: engine warranties may not provide significant incentive to improve reliability unless the reliability growth rate is high or there is a substantial increase in penalty payments or a decrease in the cost to obtain reliability growth. They also observed that small improvements in reliability before fleet introduction might be more economical than present practice of growing reliability after deployment. It was also concluded that reliability improvement benefits outweigh penalty payments. A suggested negotiation range in pricing a warranty (using the developed methodology) would be between the manufacturer's minimum price and the present value of the expected total benefit.

Further research was recommended in the areas of: (a) refinement and validation of the methodology developed by using field data; (b) a further analysis of relative costs for growing reliability before and after fleet introduction; and (c) evaluating the incentives provided by each of the various contract incentive techniques such as award fee, design-to-cost, and value engineering in terms of their ability to achieve LCC objectives.

LIFE CYCLE COST (LCC)

Area Manager: Captain Paul W. Gross, Jr.

Objective: The objectives are twofold: First, to develop and/or evaluate the various methods and techniques to reduce life cycle costs (LCC) (e.g., reliability improvement warranty) and second, to improve methods to identify, measure, and evaluate primary LCC drivers during the acquisition process.

Background: The objective of LCC is to reduce ownership costs by considering both acquisition and logistics support costs in decisions made during acquisition. The availability and accuracy of such cost data normally increase from the time the requirement originates. Therefore, it may be necessary to use different techniques to evaluate LCC during various time frames depending on the availability of LCC information. Early in the cycle, it is desirable to identify the cost drivers and make trade-off decisions between the requirement and the LCC. As the requirements become firm, LCC becomes more of a criteria to evaluate the best source among competing firms. Later in the cycle, it is necessary to incorporate the factors which indicate the need for equipment repair or replacement, e.g., flying hours, operating hours, landings, age, and extent of exposure to environmental conditions. More knowledge is needed of the changing nature of data requirements, cost drivers, and cost projection techniques if the LCC concept is to be of maximum assistance.

Projects Completed(*)/In Progress:

*1. Project Number D-3-2-77. "An Identification and Characterization of Cost Models/Techniques Used by AFLC to Estimate Jet Engine Operations and Support Cost," Captains G. Davidson and R. Griffiths. AFIT. Advisor: Lieutenant Colonel M. Martin.

a. Summary: The Life Cycle Cost (LCC) for jet engines includes the cost of design and development; test and evaluation; production; operation and support; and where applicable, disposal. Although only a small portion of the total LCC is incurred prior to production, the decisions made up to that point determine most of the total engine LCC. During early design there is insufficient operational information on the new engine to permit prediction of costs incurred during the operation and support phase of LCC. LCC estimation is further hindered by lack of knowledge about techniques which could be used during engine design. This research involved a systematic investigation of the models and techniques used by the Air Force Logistics Command (AFLC) to estimate jet engine operation and support cost. These models and techniques are used in the areas of requirements determination for recoverable spares, engine overhaul, and total annual support-cost estimates for recoverable items. They are characterized to allow a

determination as to their applicability for use during engine design.

b. Significance: The research provides a detailed description of characteristics of the various AFLC cost estimating models/techniques on jet engines. The models/techniques (in which at least part of their function is to estimate cost) are: the DO24, Propulsion Units Logistics System; the DO41, Recoverable Consumption Item Requirement Computation System; the DO62, Requirement Procedures for Economic Order Quantity (EOQ) Items; the GO72A, Depot Maintenance Production Cost System; the Cost and Performance Ranking Model (COSPERANK); the Logistics Support Cost (LSC) Model; and the Cost Estimating Relationship (CER). Only two of the models, the LSC model and the CERs, are used for LCC estimates. However, the other AFLC models are used as a meaningful part of the AFLC budget estimating process.

*2. Project Number D-3-3-77. "Review of the Application of the Operations and Support (O&S) Cost Model to the A-10 Program." Captain A. Moxon, C1C M. Clark, and C1C G. Forsyth. Air Force Academy/DFEGM. AFALD/CV Sponsored. Research Directors: Captains R. Fellows and P. Gross.

a. Summary: The purpose of the study, which was initiated at the request of the Air Force Acquisition Logistics Division (AFALD), was to document and evaluate the application of the Operation and Support (O&S) cost model used in the A-10 program. The application of the model was an attempt by the Air Force to accomplish the goals of DOD Directive 5000.28. This cost model application is primarily a contracting technique intended to encourage the contractor to design lower O&S costs into a weapon system during the development and production phase of the acquisition cycle through design improvements. The research results indicated that:

(1) The model was useful to the program office,

(2) The O&S cost may have been significantly reduced,

(3) The O&S cost impact was continuously emphasized during the contract performance period,

(4) The cost of implementing the technique both in terms of manpower and funds expended was well within manageable limits,

(5) The contractors were positive supporters of the model and both indicated it was useful,

(6) The model can be applied to both major systems and subsystem acquisition programs, and

(7) The model is a performance measurement technique and, as presently exists, cannot be used to project total life cycle cost (LCC).

b. Significance:

The study critically reviews the implementation of the cost model on the A-10 program and provides a list of lessons learned, a critical analysis of the technique, and recommendations. The researchers found that the technique was very useful and favorably impacted the O&S costs of the weapon system. The researchers also identified several weaknesses and implementation problems that should be of concern to program managers, cost analysts, and decision makers to the acquisition process. This O&S model has wide application for other system acquisitions. Follow-on work is being considered to further evaluate the model's potential for increasing effectiveness and for use in additional LCC applications.

*3. Project Number D-3-4-77. "An Analysis of Information Sources for the Estimation of Life Cycle Operating and Maintenance Costs of Turbine Engines," Captain M. Baker and Lieutenant B. Johnston. AFIT. Advisor: Lieutenant Colonel M. Martin.

a. Summary: Operation and Support (O&S) costs comprise a significant portion of the Life Cycle Cost (LCC) of a weapon system. The purpose of the research was to locate, identify, and evaluate data bases which can be used to estimate life cycle O&S cost for aircraft engines. The search for these data bases was primarily conducted at Headquarters Air Force Logistics Command. The study focused upon the Increase Reliability of Systems (IROS) data base, the HO36B DOD Cost and Production Report, the Air Force Manual 400-1 actuarial data system, the cost and planning factors in Air Force Regulation 173-10, aerospace ground equipment data located in the Tables of Allowance, and Component Improvement Program data located at the Deputy for Propulsion, Aeronautical Systems Division.

b. **Significance:** The study provided a very good basic background on the development and complexity of Air Force turbine engine management. The researchers also prepared a good explanation of LCC and the relationship to weapon system life cycle. The authors concluded that the data bases are not well designed for cost data collection. They also concluded that many data bases are necessary to obtain the total operation and support cost of an aircraft engine.

PART II - U.S. AIR FORCE ACADEMY RESEARCH

Objective: To provide an interface between users and researchers.

Background: A number of problems faced by procurement/acquisition personnel can be studied in an academic environment. Highly qualified researchers on the faculty of the Department of Economics, Geography, and Management possess skills needed to address these problems. In recent years, we have found it a very valuable teaching tool to structure procurement/acquisition problems so that they can be studied by cadets as part of their regular curriculum. At the same time, a number of faculty members have become interested in solving some of the more complex problems. The following projects and research activities were performed during 1977. They represent a broad spectrum of activity and are indicative of the breadth of capability and interest available on the Department of Economics, Geography, and Management faculty. Research for reports or additional information should be directed to:

Director
USAF Procurement Research Office/
DFEGM
USAF Academy, Colorado 80840

Project: A Parametric Model for Nuclear Warhead Costs

This model establishes a first cut at incorporating the various factors which make up nuclear warhead costs.

Researcher: Major William J. Weida

Project: A General Technique for R&D Cost Forecasting

A model based on the expenditure patterns of twenty-one major weapon systems is used as a predictor of Research and Development expenditures for new weapon systems. Optimistic, most likely, and pessimistic cost forecasts are developed, and the fact that a general curve can depict the expenditure patterns of many different types of weapon systems is discussed. The model is

validated on fifteen additional systems and an example of an actual application of this forecasting method is provided.

Research: Major William J. Weida

Project: An Econometric Study of Aerial Interdiction in Southern Laos, 10 October 1970-30 June 1971

The basic tools of economic analysis are used to evaluate the effectiveness of air resources employed in southern Laos from 10 October 1970-30 June 1971. The primary objective of the campaign--to reduce the amount of enemy supplies reaching South Vietnam and Cambodia--is used as the basic measure of strike sortie effectiveness. Southeast Asia variable cost factors are derived and used in conjunction with production functions estimated by the technique of regression analysis to derive optimal cost-effectiveness sortie allocations. These allocations highlight the role of the gunship team in the interdiction effort and indicate fewer strike sorties against the enemy road network could have been flown. Given the strike resources available, however, the variable cost of tactical air sorties actually flown was within five percent of the estimated least-cost optimum.

Researchers: Major Gregory C. Hildebrandt, Colonel Herman L. Gilster, and Colonel Richard D. Duckworth

Project: The Rent-Buy Decision for Military Families

This report compares and contrasts the property appreciation and income tax savings advantage of home ownership to the cash-flow advantage of occupying Government quarters. An algorithm is developed for service members to use in objectively measuring and comparing the financial advantages of each option. The popular notion that the "buy" decision is always best from a financial standpoint is brought into question.

Researcher: Captain Stephen H. Russell

Project: Optimal Subsidy Functions
(in progress)

The report discusses the specific problem of controlling a monopoly when market demand is used as the basis for measuring benefits. The control tool used to achieve the regulators objectives is called an "optimal subsidy function." It is shown that while such an optimal function always exists for the one good case, when more than one good is involved existence requires equality of the market cross derivatives of demand with respect to price.

Researcher: Major Gregory G. Hildebrandt

Project: Strategic Stockpiling and Substitution

This report analyzes the strategic stockpiling methodology used by the Federal Preparedness Agency. A number of limitations of the existing approach are discussed. For example, the basic planning approach does not consider the likelihood of an emergency. This omission is justified only if substitution is not possible. Yet, there is evidence that the economy is capable of a flexible response to an emergency. Thus, an approach is suggested which explicitly accounts for the likelihood of an emergency.

Currently the demand for strategic materials is estimated using a model of a peacetime market economy with only a limited allowance made for substitution in production. The estimates of the supply of strategic materials may also be inadequate as the current procedure ignores the use of a price mechanism to activate increases in supply.

A major conclusion is that the variegated nature of strategic materials seems to imply that a more detailed analysis of each material's demand and supply characteristics be accomplished before a stockpile decision is made.

Researcher: Major Gregory G. Hildebrandt

Project: Review of the Application of the O&S Cost Model to the A-10 Program Contractor Incentive Award Fee

A final review of the application of the O&S Cost Model to the A-10 Program Contractor Incentive Award Fee was undertaken at the request of Brigadier General Rutter, Vice-Commander of the AFALD. A research proposal was developed by the Business Research Management Center at Wright-Patterson AFB, Ohio, to address four basic areas: (1) describe the background and implementation of the O&S Cost Model as applied to the A-10 program, (2) provide a critical analysis of the technique involved, (3) identify the positive effects of the A-10 O&S Cost Model application, and (4) provide a summary of the lessons learned.

Researchers: Captain Arthur L. Moxon, ClC Michael R. Clark, and ClC Glen T. Forsyth

Project: MBO in the Air Force: Summary and Annotated Bibliography

Management by Objectives (MBO) has recently been adopted by a number of major commands and individual organizations throughout the Air Force. The popularity of MBO programs has necessitated a reevaluation of what MBO is and how managers can use this technique in their organizations. This report presents MBO as a way of managing, outlining the assumptions and constraints associated with MBO programs. A step-by-step analysis of how to implement an MBO program is also provided to assist Air Force managers in understanding and implementing MBO at any level in the organization. Most important, over 100 books and articles on MBO are reviewed from the perspective of the practicing manager. Nearly 250 bibliographical entries were reviewed and only those having relevance to Air Force managers were included. Articles dealing with specific career areas such as accounting and finance, health care, maintenance, etc., combine with the classic books and articles to give the Air Force manager a thorough perspective of MBO. At the same time, this report should be a practical reference for those wanting more information on the topic.

Researcher: Major Robert L. Taylor and Lieutenant Robert Eskridge

PART III - THE RAND CORPORATION AND
AIR FORCE LOGISTICS MANAGEMENT CENTER RESEARCH

This section contains a brief description of studies currently under way or recently completed at the Rand Corporation and the Air Force Logistics Management Center (AFLMC). Readers interested in more details on these studies are urged to contact the investigator or the organization contact as indicated.

Under Project Air Force the DCS Research and Development, HQ USAF, sponsors acquisition oriented studies which are performed by the Rand Corporation. The Air Force Logistics Management Center (AFLMC) was activated in late 1975 to develop and exploit a comprehensive and coordinated program to assist the logistics community. An Air Force controlled unit, AFLMC performs studies and projects in the areas of maintenance, supply, procurement, transportation and logistics plans.

A highly qualified group of logistics experts are assigned to AFLMC including, in the Procurement Directorate, Major Kenneth L. Gerken, SMSgt Ralph R. Sutherland, and MSgt Charles B. McShain. In the procurement area, AFLMC is principally concerned with base level issues. AFLMC is located at Gunter Air Force Station, Alabama 36114; Autovon number is 921-4085.

RAND STUDIES

Development and Evaluation of Concepts and Methodologies for Improving the Air Force Spares Support Systems (John Y. Lu) RPN 3627.

Description: This project deals with stockage and distribution as strategies within a framework of alternative logistics postures, with special emphasis on meeting war-time needs. The research addresses issues relating to requirements, distribution, and procurement strategies as well as interfaces with the maintenance function at depot and base levels.

Results: A model has been completed of the three-echelon supply system, the consolidated support model (CSM). Report R-1923-PR describes the model and has been published; the associated computer program has been developed. The main features of CSM are: (a) it optimizes spares allocation in three-echelon supply systems that will complement the centralized intermediate maintenance

system; and (b) it explicitly accounts for the interdependence of stocking inventories of shop replaceable units (SRUs) and line replaceable units (LRUs).

Initial explorations indicate that for a particular subsystem or weapon system, e.g., F-15 avionics, there are some configurations of regionalized stockage decision points and intermediate level maintenance activities where increased supply cost due to the extended LRU pipeline can be offset by fewer stockage points for SRUs. If this observation can be validated under an appropriate variety of operating conditions, it will have important consequences for maintenance policy.

Methods and Applications of Life Cycle Analysis for Air Force Systems (Giles K. Smith) RPN 3609.

Description: The purpose of this project is to develop an effective methodological and managerial approach for applying life cycle analysis in the system acquisition process. There remains many unresolved questions involving the proper methodological tools and supporting data; and the nature of the institutional, organizational, managerial, and other environmental factors that influence the need for and effective use of life cycle analysis. Thus the project emphasizes life cycle cost analysis, methodology, and application. Concentration is on developing life cycle cost analysis techniques and aggregate measures of O&S costs that can provide visibility on magnitudes, proportions, and trends of O&S costs and thus can be used to evaluate specific life cycle cost tradeoffs during acquisition. Concurrently, but at much lower levels of effort, work is being performed on: (a) the basic design of improved cost analysis models and the associated specification of data needs--the latter to complement the USAF operating and support cost reporting system (OSCR) and related data system improvement efforts; (b) an investigation of organizational and institutional factors within the acquisition process that may be contrary to life cycle policy objectives; (c) the feasibility and control of O&S costs in the Air Force program and budgeting systems; and (d) problems and opportunities in the use of warranty and incentive clauses in acquisition contracts as a way of controlling O&S cost.

Results: Formal models now available suffer from important limitations of scope and precision. These deficiencies cannot be corrected until more fundamental improvements have been made in standards and procedures for O&S cost accounting and collection of actual O&S cost experience. Work is under way to develop a preliminary set of experience base and estimation rules which will be useful to Air Force staff personnel for a wide variety of life cycle analyses. A review of existing program change proposal decision procedures reveals that a large degree of variation in scope and quality of support analysis involving life cycle cost estimates exists. The communication of problem descriptions and results between various agencies and echelons is a significant factor in the overall life cycle analysis problem. A draft of suggested procedures and formats for recording and presenting analysis results is expected to be available soon.

Ongoing and future concentration under this project is aiming at developing ideas concerning the desired organization and structure of a family of improved O&S cost estimation models. We are also reviewing recent experience with warranty and incentive clauses in acquisition contracts as a means of improving component reliability and reducing support cost, and developing near term estimation aids, data bases, and analysis procedures for use by Air Staff and field agencies charged with analysis and evaluation of life cycle cost.

System Acquisition Policy Studies
(Giles K. Smith) RPN 3712.

Description: This project's goal is to aid the Air Force as a buyer of research technology and new weapons and support systems and subsystems in the identification of description of long-term, basic problems. It is expected that sustained research will lead to useful new concepts and policy innovations. Although largely focused on major systems, the research also includes key subsystems wherever it can provide useful insights into the relevance of particular procedures, institutional arrangements, or development practices.

Three interrelated sets of research topics are included: (a) broad strategy concepts, such as the use of prototypes to reduce technical and financial risk and the application of sequential or

phased acquisition procedures; (b) development and improvement of analytical techniques needed to implement broad acquisition strategies such as the prediction of expected outcomes where technological uncertainty is great. Here the derivation of risk-estimation tools and practical, operationally useful performance, cost, and schedule prediction methods is a continuing goal. Attention is also being directed to evaluation of contracting techniques such as warranty incentive clauses; (c) in addition, some effort is being devoted to understanding the influences exerted by such external factors as institutional arrangements, attitudes, and financial procedures that exist throughout the DOD and the Congress, and describing how these effect the implementation of various acquisition strategies.

Results: Several acquisition programs begun during the early 1970's are under continual review with attention being directed toward those that employed prototypes in different ways. Comparisons are being made with earlier programs to evaluate effectiveness of the different procedures introduced. In addition, a simulation model, based on data developed under several past programs, is being refined with the goal that its results can be applied with confidence to a new acquisition program. As part of this effort, a separate study has been undertaken to determine the cost impact of different production rates since increased costs in the past have been a major objection to proposals that production rates be maintained at relatively low level until major performance and reliability problems were resolved.

Spacecraft Acquisition Strategies
(Bruno W. Augenstein) RPN 3782.

Description: This project is aimed at developing improved methods for acquiring spacecraft for Air Force space missions. Previous research has investigated the basis of reliability prediction and associated methods used for procuring and launching spacecraft, cost of achieving various levels of reliability, and ways of exploiting and capitalizing on the much longer life times of current and prospective spacecraft. These findings have been assembled into a proposed new spacecraft, procurement and launch concept called "Bunched Acquisition."

Results: The "bunching" concept is based on the finding that very long satellite orbital lifetimes are achievable, limited in the end largely by wear out or expendable consumption rather than component failures. Thus, one can consider the utility (for missions requiring multiple satellites and orbits simultaneously) of launching, over a very short time interval, all of the satellites needed in a particular program for a five or ten year period, and storing the initial, unneeded satellites in orbit in a dormant mode. In addition to some benefits in the area of proliferation, the procedure also produces the fastest reaction time for replacing the functions of an inoperable satellite. Its use would avoid the need for dependence on complex computer models to predict satellite needs, production rates, quantities, and launch schedules. In addition, the "bunch" procurement concept has potential advantages in alleviating the inflation effects, optimizing satellite production rate and learning curve effects and reducing management, overhead, and personnel costs. The "bunching" concept would involve a number of institutional changes, thus much effort has been devoted to sorting and evaluating the appropriate elements of an implementing rationale. In addition, work is being directed at space shuttle related issues and to the development of the information base needed for better understanding of these issues.

Industrial Base Study (Alvin J. Harman/Geneese G. Baumbusch) RPN 3784.

Description: This project is directed at establishing an understanding of the ability of the "lower tiers" of the Defense industrial base to support DOD production needs. Initial fears that the peacetime resource base was inadequate have appeared unjustified. Therefore, research emphasis has shifted to nonpeacetime situations. Research is now focusing on a refinement of the concept of surge and on identifying the cost required for achieving various levels of industrial capability to meet surge requirements, assuming that some sectors of industry are found to have inadequate capability in the potential crisis situation.

Results: The concept of surge has proved to be difficult to refine. It now appears that full understanding of surge contingencies would require development of elaborate scenarios and analysis of these over long periods. However,

several dimensions of crises have been defined for working purposes, questions arising from the possible participation of U.S. forces in a potential conflict have been addressed, and these elements of the problem are being included in an examination of procurement requirements for whole systems, spares, and war reserve material (WRM) which might be levied on industry. The key uncertainty is whether industry could make a timely response, and as of now even defining timely remains a difficult problem. Additional research will be devoted to a further understanding and refinement of surge requirements and evaluation of the adequacy of the lower tiers of selected sectors of the industrial base.

CURRENT AFLMC PROJECTS:

Base Level Support Contracts

Description: The objective of this project is to define ways of raising the quality of base level services contracts by improving specifications and administration. Study results to date indicate that the solution to this problem lies in viewing services as a system of inputs, outputs, and processes. This permits definition of measurable performance against standards. Application of this concept to specifications is through systems analysis. To improve contract administration, classic production quality control and quality assurance concepts have been used. The study mechanism for this project was a newly started vehicle operations and maintenance contract at Maxwell AFB, AL. The concepts developed were incorporated into a guide specification, a surveillance plan, and a proposed Air Force Manual. The latter document incorporates the concepts into a useable, step-by-step method for writing quality specifications and an associated quality assurance surveillance plan.

Technical Representative of the Contracting Office (TRCO) Training Effectiveness

Description: The purpose of this project is to find out what TRCO training exists, to recommend improvements, and to introduce objective Air Force standards for TRCO training. This project involves gathering documentation from major commands and training centers to determine what is being taught, and interviewing TRCOs and Procurement personnel at 19 selected bases, to

determine what needs to be taught. Data gathered will be compared, and the actual training needs and inconsistencies analyzed to establish a basis for formulating enhanced training objectives. Alternative training approaches will be appraised and recommended changes pertaining to subject matter, media, methods, and materials will be developed. A final report of findings and conclusions including recommended policy and procedural changes will be prepared. In addition, a proposed TRCO training syllabus intended for use as an Air Force standard will evolve.

PART IV - BIBLIOGRAPHY OF COMPLETED STUDIES

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